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ABSTRACT

How data gathered through item response theory (IRT) analysis can be used to give immediate diagnostic information without a computer is explained. The Kidmap, developed by B. D. Wright and others (1980), provides clear information in a visual manner. Its major problem lies in the need for a computer and suitable software to construct a Kidmap. The solution lies in the proposed diagnostic map (DIAMAP). Once items have been calibrated and a raw score to logits equivalence established, items that would normally be placed in correct and incorrect columns on a Kidmap are put on either side of the central raw score scale. Items answered correctly on the "correct" side are circled, and incorrectly answered items on the "incorrect side" are circled. The raw score is marked on the central column and interpretation proceeds as for a Kidmap. An analogous version is also created for rating scale analysis; this version can give an immediate understanding of the measured trait for every respondent, based solely on raw score. This brief outline of the construction and use of DIAMAPs illustrates that good reporting methods can make IRT analysis more pertinent to the lay user. Eight figures illustrate Kidmaps and DIAMAPs. A nine-item reference list is included. (SLD)

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DIAMAPS – SELF SCORING KIDMAPS

Brian A. Doig

The Australian Council for Educational Research

The purpose of this paper is to explain how data prepared through Item Response Theory analysis can be used to give immediate diagnostic information without the need for a computer.

In his farewell 'A Note from the Chair' David Andrich (1992), with reference to Item Response Theory analysis, asks

> "Why has so much good work done over so many years by so many dedicated, intelligent people been so ignored by the leaders of the educational community?"
>
> (page 191)

The reasons for this state of affairs may be obscure but I would like to suggest a possible cure. Better reporting of analysis! It is my belief that first class reporting of results of analyses would promote a wider use of IRT. If IRT methods are more informative, then they will gain more favour within the educational community and a more useful tool is more likely to be used.

The function of analysis, as is said frequently at these meetings, is to let the data speak for themselves, but it is most often the case that the analysis, no matter how psychometrically sound, does not give the data a clear voice. This is true whether the analysis is traditional or Item Response Theory based.

The exception to this is of course where Kidmaps (Wright, Mead and Ludlow; 1980) have been produced by such analysis programs as TITAN. The Kidmap provides in a visual manner, clear information , information that otherwise would be hidden in the welter of tables and figures produced by the analysis.

The advantages of the Kidmap over the usual stanines, percentiles and whatnots is clear once one has used it. A classic case of a Kidmap giving immediately useful diagnostic information is shown in Figures 1 and 2.

Figure 1 gives the first picture or map of Tony's knowledge in basic arithmetic. There are six items whose difficulty would lead one to expect Tony to get them correct (D17, D13, E04, C14, C07, and E14). As has been noted by his teacher there is a major problem with subtraction.

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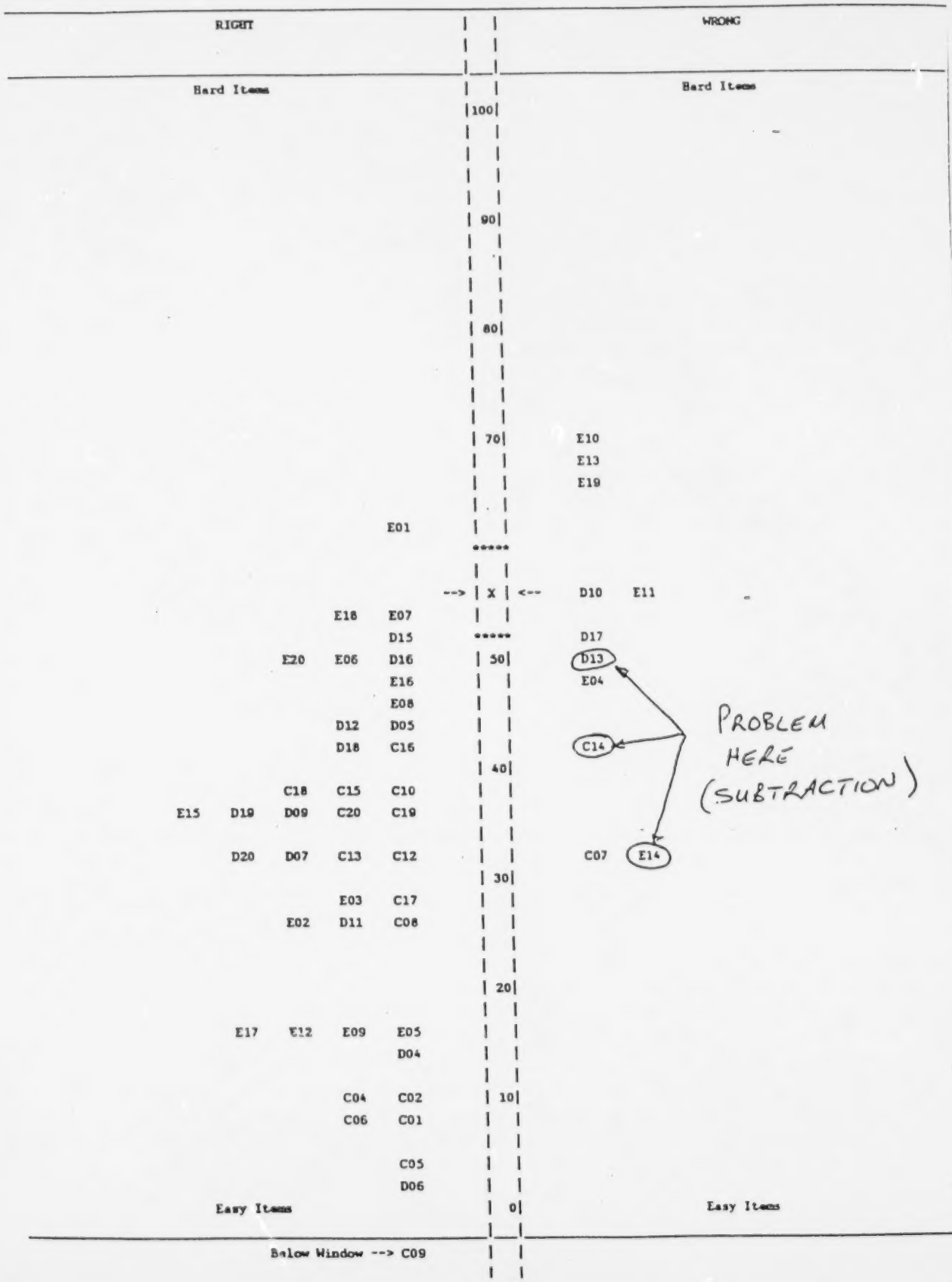
Figure 1: Kidmap for Tony in basic arithmetic (Masters et al; 1987).



The second of Tony's Kidmaps, constructed a year later, shows that his subtraction problem has not been corrected and is now considered serious.

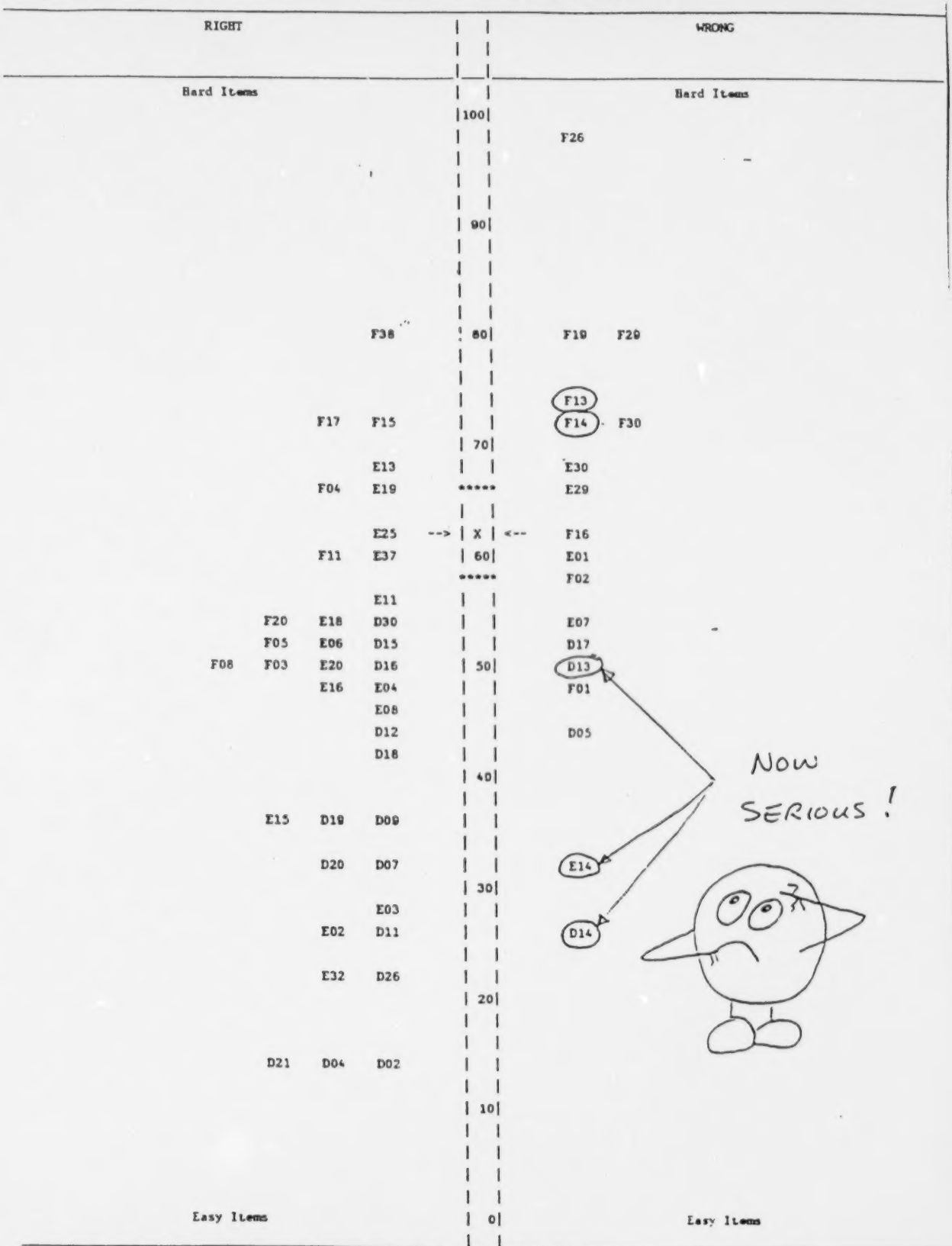


Figure 2: Second Kidmap for Tony (Masters et al; 1987).

The guidance for teachers provided by the Kidmap is a major advantage of over traditional reporting methods, where often one cannot see the wood for the trees. However even the Kidmap has disadvantages! The major problem lies with the need for a computer and suitable software to construct such Kidmaps. The solution lies in what I have called a diagnostic map or DIAMAP.

The idea of the DIAMAP is quite simple. Once items have been calibrated and a raw score to logits equivalence established, a modified Kidmap can be constructed. The modification is to take the items from the Kidmap, which normally would be placed in the correct and incorrect columns as appropriate, and put them all in both columns at either side of the central raw score scale. This gives a DIAMAP like the one in Figure 3.

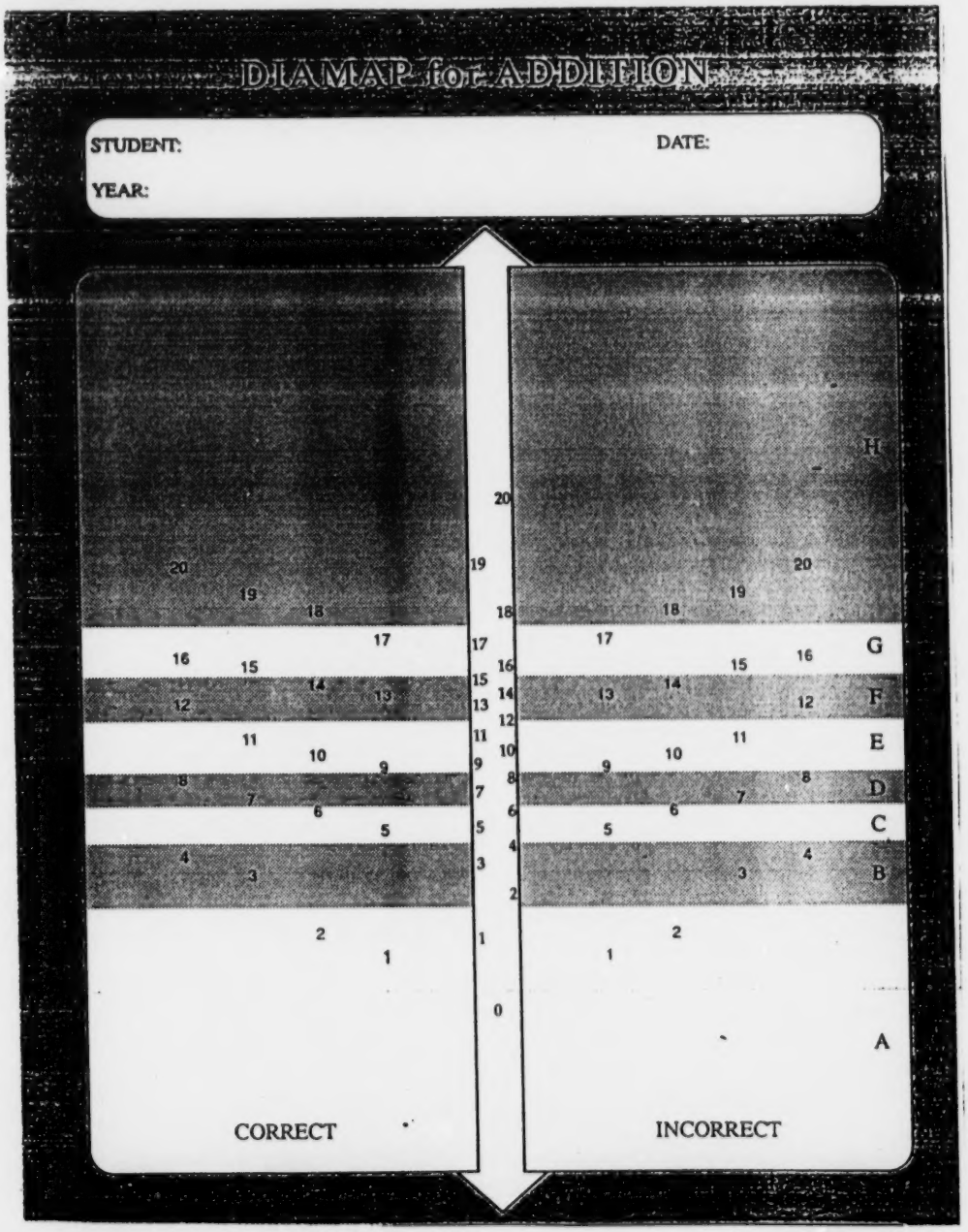


Figure 3: Sample DIAMAP (Doig; 1990).

The next step in the construction of the DIAMAP requires one to circle all those questions which have been answered correctly on the 'correct' (left hand side) of the DIAMAP and to circle only the incorrectly answered questions on the 'incorrect' (right hand side) of the DIAMAP. Finally, the raw score is marked on the central score column. The interpretation of the DIAMAP then proceeds as for a Kidmap. An example of a completed DIAMAP from the Diagnostic Mathematics Profiles (basic arithmetic) is shown in Figure 4.

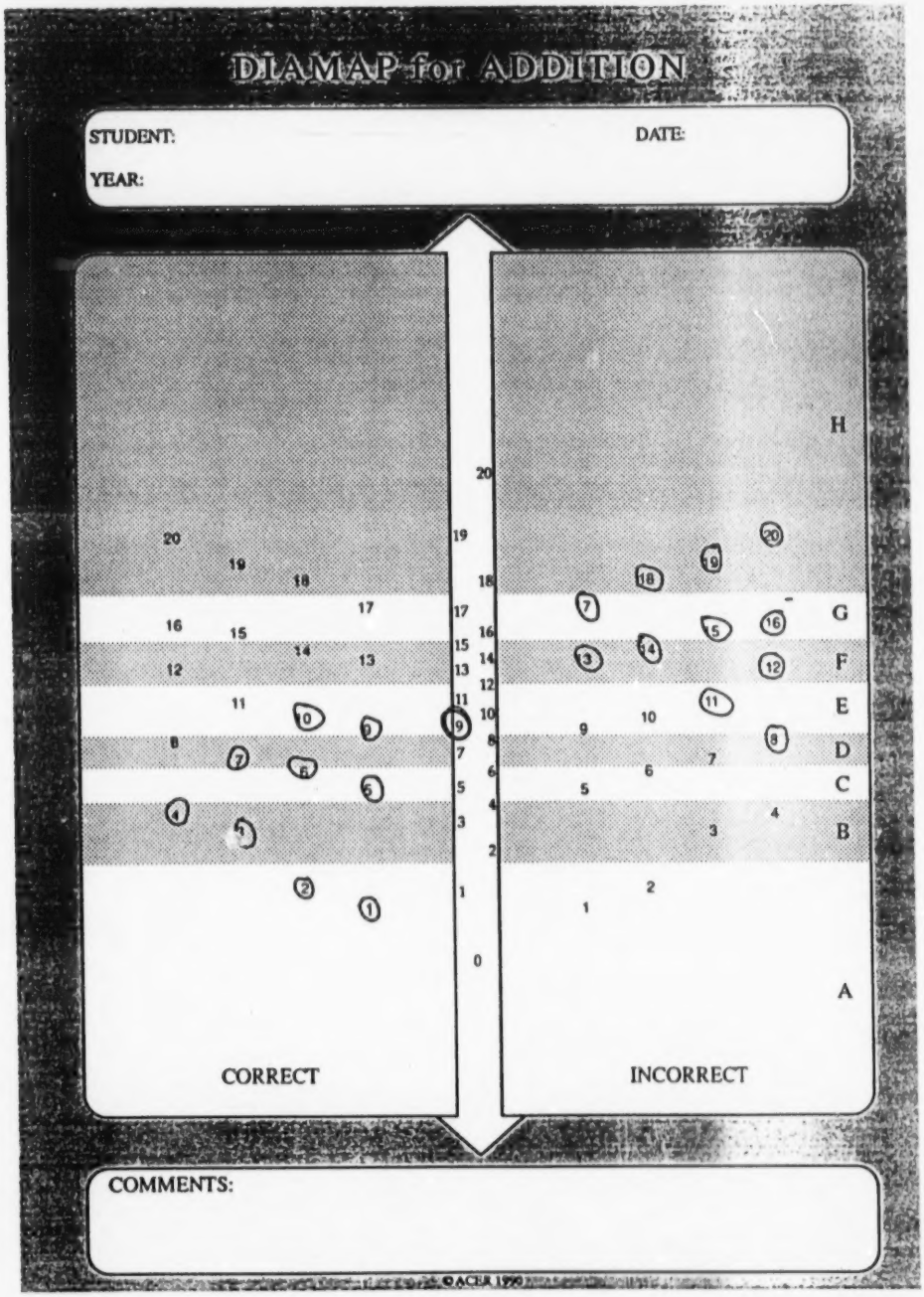


Figure 4: Completed DIAMAP from the Diagnostic Mathematics Profiles (Doig; 1990).

To further assist in interpretation, a DIAMAP can be divided horizontally into 'bands' or 'levels' for which descriptions are provided. This process is well illustrated by Figure 5, which is the DIAMAP for the Australian Language Certificate in French Listening (Zammit; 1991).

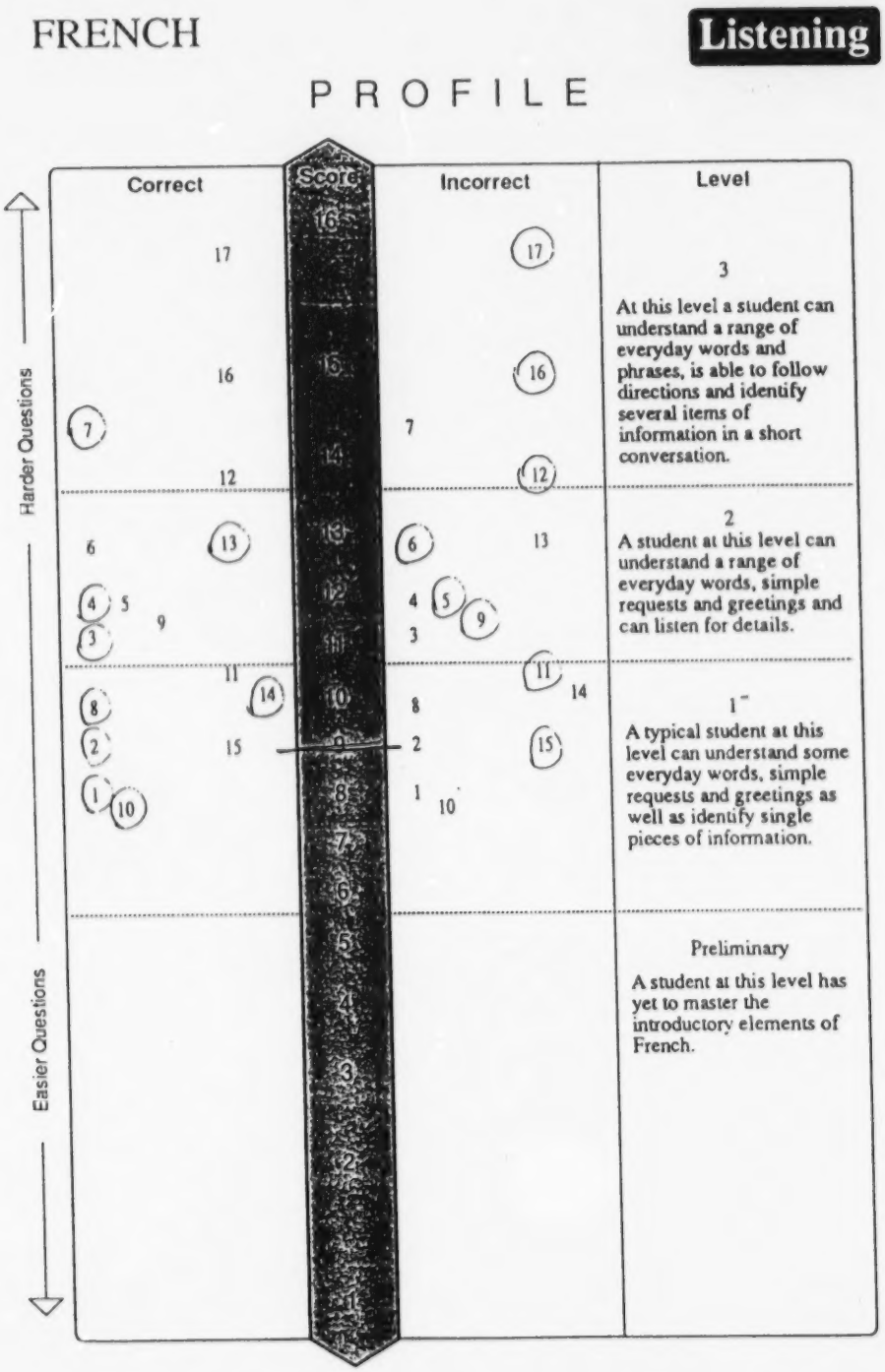

FRENCH
Listening
PROFILE
Correct
Score
Incorrect
Level
Harder Questions
Easier Questions
3
At this level a student can understand a range of everyday words and phrases, is able to follow directions and identify several items of information in a short conversation.
2
A student at this level can understand a range of everyday words, simple requests and greetings and can listen for details.
1
A typical student at this level can understand some everyday words, simple requests and greetings as well as identify single pieces of information.
Preliminary
A student at this level has yet to master the introductory elements of French.

Figure 5: Completed DIAMAP from the Australian Language Certificate in French (Listening) (Zammit; 1991).

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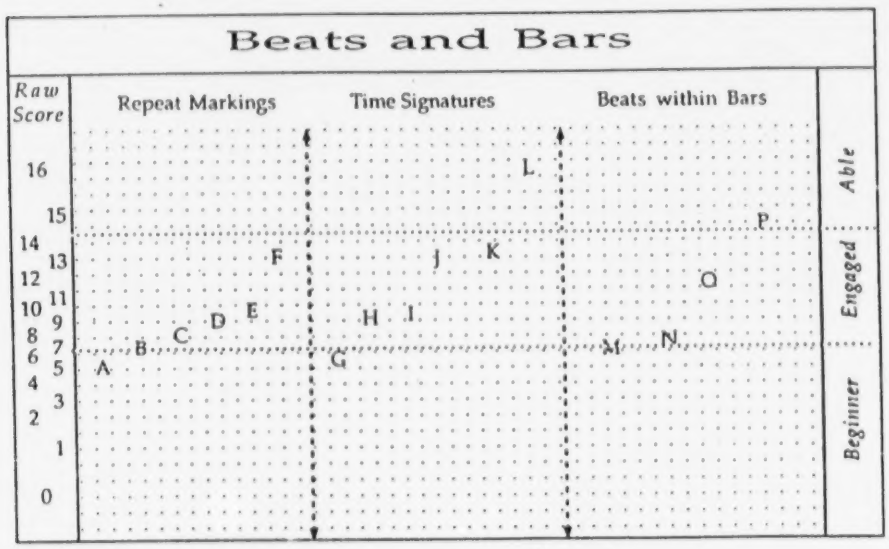
DIAMAPs need not be identical in either their lay-out or in the manner in which they are marked. For example, the DIAMAP for the 'Beats and Bars' music assessment shown in Figure 6 uses a 'triple' version to show the three sub-tests at one glance (Brown and Doig; in preparation).

Beats and Bars DIAMAP

Name _____ Class _____



Comments _____

_____

_____

Outline of Test Item Topics	Questions
Repeat Markings	
Draw repeat marks	A
Rewrite bars using repeats.	B
Rewrite bar order, interpreting repeats	C
Count the notes in a repeated passage.	D
Write full order of bars that use time bars.	E
Count the repetition of a bar in music with time bars.	F
Time signatures	
Draw time signature in position on stave	G
Write a 4/4 rhythm.	H
Describe function of the top number in time signature.	I
Describe function of the bottom number in time signature.	J
Identify the correct time signature of music.	K
Complete a bar with notes/rests according to the time signature.	L
Beats within a bar	
Indicate beats in bars of music.	M
Indicate notes not on the beat.	N
Write the beats under notes in the bars.	O
Mark certain beats in the music	P

Figure 6: DIAMAP for Beats and Bars Music Assessment (Brown and Doig; in preparation).

The marking for this music DIAMAP uses circles to indicate correctly answered questions and boxes to identify incorrectly answered questions. This helps to minimise the number of items on the DIAMAP when a lot information needs to be included on the page. The Tests of Basic Skills in Language DIAMAP of Figure 7 shows another variant. This time it was thought necessary to show items ommitted, so these were enclosed in boxes to distinguish them from the other 'incorrect' items.

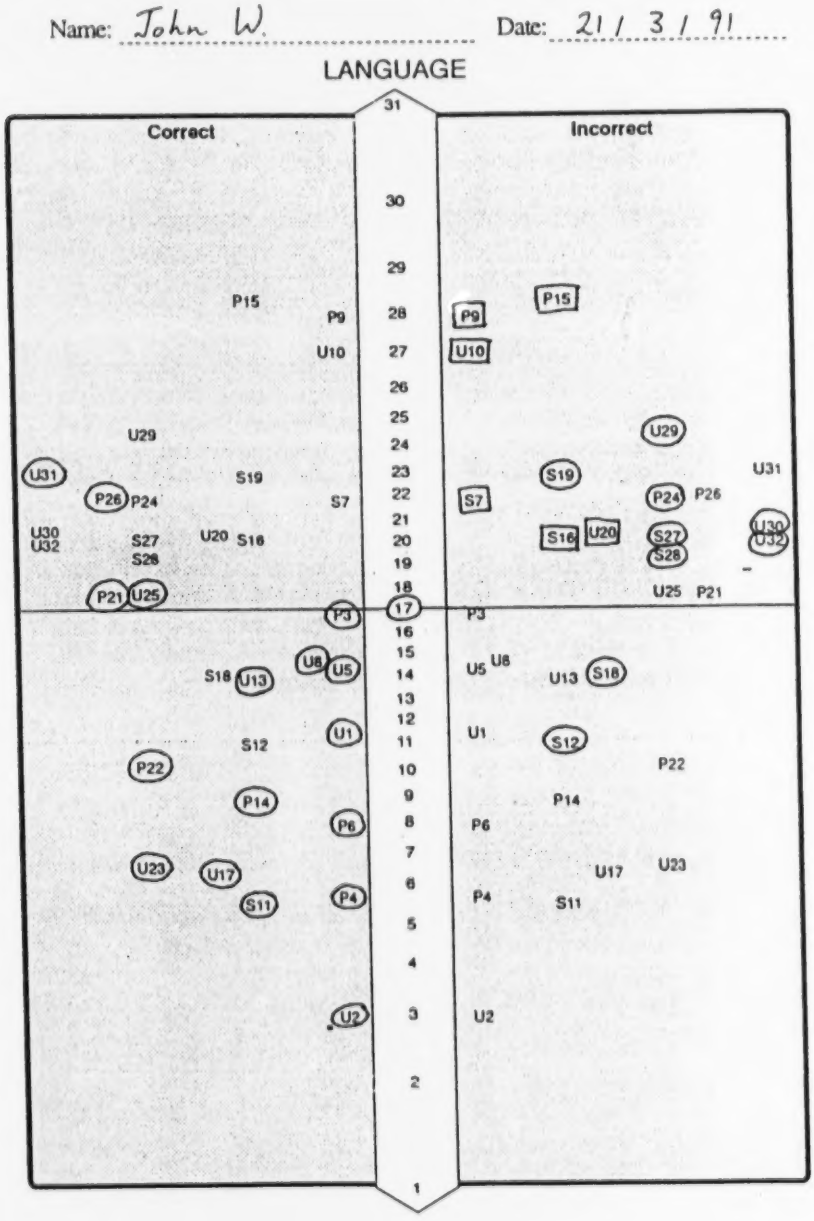


Figure 7: Completed DIAMAP from the Test of Basic Skills (Lokan; 1991).

A further step in the development of the DIAMAP is to create the analogous version for rating scale analysis. A typical problem is that traditional methods leave one without a 'feel' for the individual's results. For example, in attitude measurement, a score of 60 on a 30 item, four category (1, 2, 3, or 4) questionnaire gives no indication of the respondent's attitude to particular questions, or sub-sets of questions. However the use of Rating Scale analysis can improve the information gained from such questionnaires as shown by Masters and Hyde in their study of attitude to school (Masters and Hyde; 1984). As in the case of the standard Rasch DIAMAP, a Rating Scale DIAMAP can give an immediate understanding of the measured trait for every respondent, based solely on their raw score!

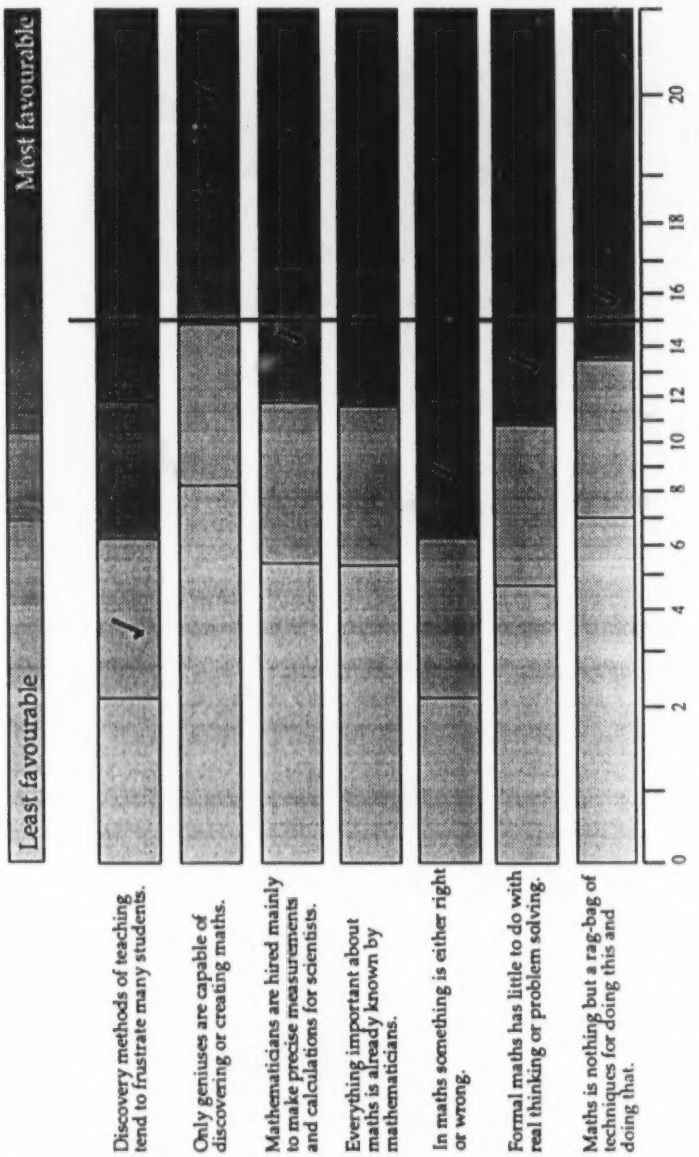

Most favourable
Least favourable
0
2
4
6
8
10
12
14
16
18
20
Discovery methods of teaching tend to frustrate many students.
Only geniuses are capable of discovering or creating maths.
Mathematicians are hired mainly to make precise measurements and calculations for scientists.
Everything important about maths is already known by mathematicians.
In maths something is either right or wrong.
Formal maths has little to do with real thinking or problem solving.
Maths is nothing but a rag-bag of techniques for doing this and doing that.

Figure 8: Boyd-Doig Mathematics Beliefs Inventory (Boyd and Doig; 1990).

Figure 8 shows a Rating Scale DIAMAP for the Boyd-Doig Mathematics Beliefs Inventory (Boyd and Doig; 1990). This is a thirty-two item , four category, Likert instrument assessing beliefs about mathematics and its teaching. The

thresholds for each category of response to a question is represented by a horizontal box of appropriate logit length, and the scaled raw scores form the horizontal axis. The actual response category of the respondent is ticked, while reading upwards from the respondent's raw score gives their most likely response to any item. In this way it is easy to identify aspects of belief which may be of most concern to the DIAMAP constructor.

For example, in the DIAMAP shown in Figure 8, the response given to the first question indicates a belief that discovery methods of teaching may be frustrating to students. The raw score generated by the responses to all questions would indicate that this response is surprising for this respondent. Such surprising responses can be the basis for further investigation. A similar perspective can be taken of responses which appear to be more positive than expected, and be used as a foundation for building a better over all attitude.

This brief outline of the construction and use of DIAMAPs should serve to illustrate that good reporting methods can make Item Response Theory analyses more pertinent to the lay user and underscore the gains that can be made from using better analysis techniques. It is to be hoped that others will further develop the DIAMAP and thus improve the image of IRT specifically and good psychometrics in general.

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